

GEEL 2000 LANGUAGE SCHOOLS

SCIENCE DEPARTMENT

PHYSICS

SEC.2

FIRST TERM (2025/2026)

CH.(1,2,3)



UNIT (1) CHAPTER (1) PHYSICAL MEASUREMENTS

MEASUREMENT PROCESS:

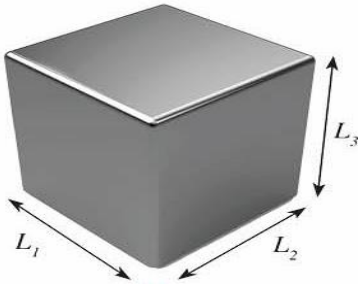
Process of comparing an unknown quantity with another quantity of its kind to find out how many times the first includes the second.

Key elements of measurement process:

- 1- Physical quantity.
- 2- Measuring tools.
- 3- Measuring units.



Physical quantity

Fundamental quantities	Derived quantities
Can't be defined in terms of other physical quantities.	Can be defined in terms of the fundamental physical quantities.
Ex: Mass (m), Length (L) and Time (t)	Ex: Volume, speed area and density. 

Measuring tools

-In ancient times: Human used parts of his body like : hand span ,arm and foot to **measure length**.

-Sunrise ,sunset and Moon phases to measure **time**.

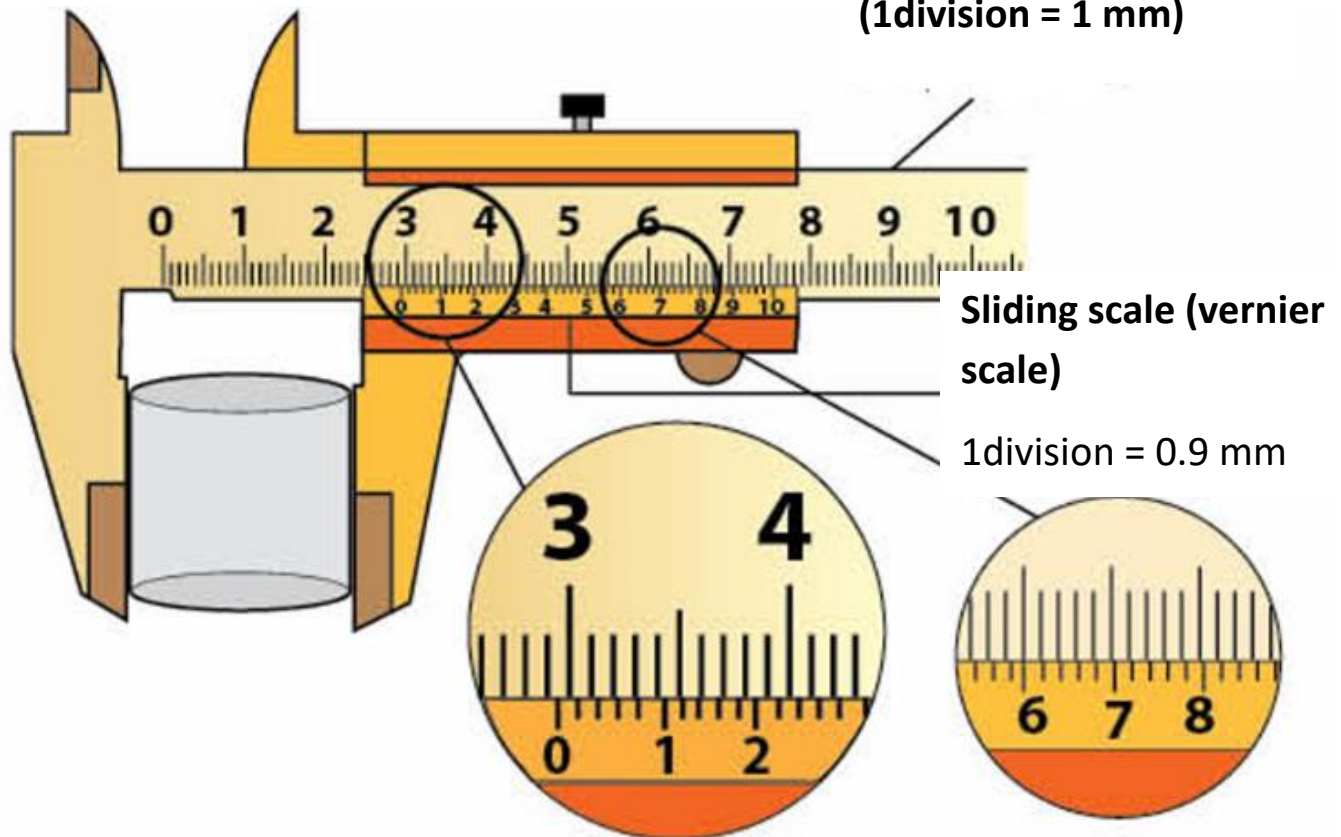


Length	Mass	Time
1- Meter Tape. 2- Vernier Caliper. 3- Ruler. 4- Micrometer.	1- Roman Scale. 2- Two pan Scale. 3- One pan Balance. 4- Digital Balance.	1- Hourglass. 2- Stopwatch. 3- Pendulum clock. 4- Digital Watch.
 	  	   

Structure of vernier caliper

Fixed Scale

(1 division = 1 mm)



-In the opposite figure what's the diameter of this cylinder?

How it is used

1. The object is placed between the two jaws of the caliper and gently pressed.
2. The length of the object is determined from the relation :

$$\text{The length} = X + x$$

Where: (X) is the reading on the **fixed scale** which is recorded before the zero mark of the vernier scale.

(x) is the **vernier reading** which is determined by finding out the mark on the vernier scale that perfectly lines up with one of the marks on the fixed scale and multiplying it by the difference between the divisions on the fixed scale and the divisions on the vernier scale (i.e., multiplying it by 0.1 mm).

Measuring units

	The French system (C.G.S)	The British System (F.P.S)	The Metric System (M.K.S)
Length	Centimeter (cm)	Foot(ft)	Meter (m)
Mass	Gram(g)	Pound (lb)	Kilogram(Kg)
Time	Second(s)	Second(s)	Second(s)

(International System of units) SI units

The Physical Quantity	The international Units
Length(L)	Meter(m)
Mass(M)	Kilogram(kg)
Time(t)	Second(s)
Electric current intensity(I)	Ampere(A)
The absolute temperature(T)	Kelvin(k)
Amount of material (n)	Mole(mol.)
Luminous intensity (I_v)	Candela(cd)
Angle measurement	Radian
Solid angle measure	Steradian

Standard units

Standard

(Length) meter

It is the distance between two engraved marks at the ends of a rod made of Platinum and Iridium alloy kept at 0°C, at the international bureau of weights and measures near Paris.



The Standard Mass (Kilogram)

It is the mass of a cylinder made of Platinum and Iridium alloy of specific dimension kept at 0°C, at the international bureau of weights and measures near Paris.



The Standard Time (Second)

The Second = $\frac{1}{86400}$ of the average solar day.

Note: Platinum Iridium used in making standard units:

Bec. Its rigid, chemically inactive and doesn't affect the surrounding temperature.

-Scientists use atomic clocks like: **Cesium clock** because of its high accuracy.

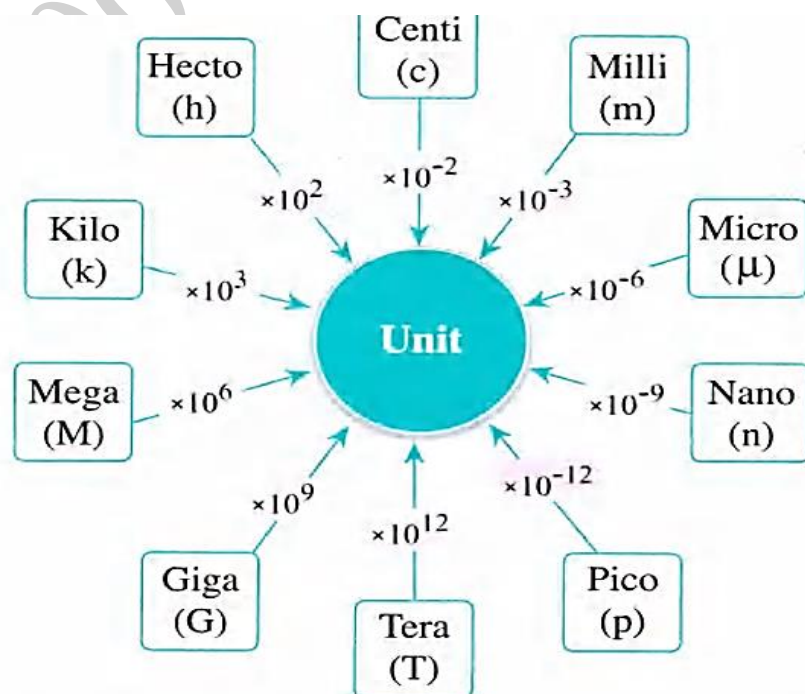
It used for :

- 1-Determine the duration of The Earth spin (day length).
- 2- Tuning up the clock used for aviation and navigations.
- 3-Synchronizing the devices used in space ships.



The cesium atomic clock

Prefixes



Example 1

A car moved a distance of 5 km, so this distance is equivalent to

- (a) 5×10^{-5} cm (b) 5×10^{-2} cm (c) 5×10^2 cm (d) 5×10^5 cm

Solution

$$s = 5 \text{ km} = 5 \times 10^3 \text{ m} = 5 \times 10^3 \times 10^2 \text{ cm} = 5 \times 10^5 \text{ cm}$$

∴ The correct choice is (d).

Example 2

The length of a particle was measured using an instrument, it was found to be $3 \mu\text{m}$, so the length of the particle equals

- (a) 3×10^9 km (b) 3×10^3 km (c) 3×10^{-3} km (d) 3×10^{-9} km

Solution

$$l = 3 \mu\text{m} = 3 \times 10^{-6} \text{ m} = 3 \times 10^{-6} \times 10^{-3} \text{ km} = 3 \times 10^{-9} \text{ km}$$

∴ The correct choice is (d).

The Star of Africa diamond is the largest cut diamond in the world and it is kept in the tower of London. If the volume of this diamond is 30.2 cm^3 , then its volume in m^3 equals

- (a) 30.2×10^3 (b) 30.2×10^{-2}
(c) 30.2×10^{-6} (d) 30.2×10^{-9}

Solution

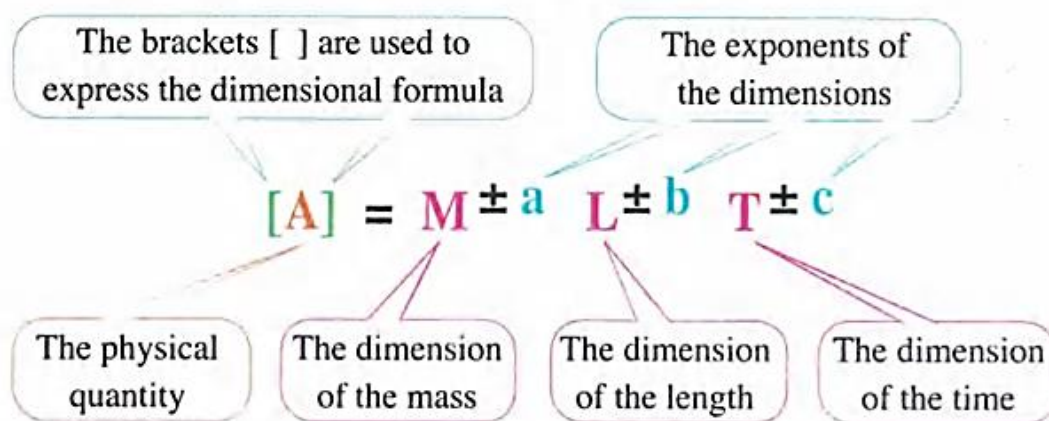
$$V = 30.2 \text{ cm}^3 = 30.2 \times (10^{-2} \text{ m})^3 = 30.2 \times 10^{-6} \text{ m}^3$$

∴ The correct choice is (c).



Dimensional formula

-Mass is denoted by **M**, length is denoted by **L** and time with **T**



⇒ The following table shows the dimensional formulae of some derived physical quantities and their measuring units:

The physical quantity	Its relationship to other quantities	The dimensional formula	Unit of measurement
Area (A)	$A = \text{Length} \times \text{Width}$	$[A] = L \times L = L^2$	m^2
Volume (V)	$V = \text{Length} \times \text{Width} \times \text{Height}$	$[V] = L \times L \times L = L^3$	m^3
Density (ρ)	$\rho = \frac{\text{Mass}}{\text{Volume}}$	$[\rho] = M L^{-3}$	kg.m^{-3}
Speed (v)	$v = \frac{\text{Distance}}{\text{Time}}$	$[v] = L T^{-1}$	m.s^{-1}
Acceleration (a)	$a = \frac{\text{Change of speed}}{\text{Time}}$	$[a] = L T^{-2}$	m.s^{-2}
Force (F)	$F = \text{Mass} \times \text{Acceleration}$	$[F] = M \times L T^{-2} = M L T^{-2}$	kg.m.s^{-2}
Momentum (P_L)	$P_L = \text{Mass} \times \text{Speed}$	$[P_L] = M L T^{-1}$	kg.m.s^{-1}
Work (W)	$W = \text{Force} \times \text{Displacement}$	$[W] = M L^2 T^{-2}$	$\text{kg.m}^2.\text{s}^{-2}$

If the acceleration is defined as the time rate of change of speed, then the dimensions of acceleration (a) and its measuring unit are

	Dimensions	Measuring unit
(a)	LT^{-1}	$m.s^{-1}$
(b)	LT^{-1}	$m.s^{-2}$
(c)	LT^{-2}	$m.s^{-1}$
(d)	LT^{-2}	$m.s^{-2}$

Solution

$$\text{Acceleration} = \frac{\text{Change of speed}}{\text{Time}} = \frac{\text{Distance / Time}}{\text{Time}}$$

$$\therefore [a] = \frac{L/T}{T} = \frac{LT^{-1}}{T} = LT^{-2}$$

$\therefore$ The measuring unit of acceleration is $m.s^{-2}$.

From the following equation: $x = C_1 t + C_2$, the measuring unit of the quantity C_1 is (Where: (x) is the distance in meters and (t) is the time in seconds)

(a) m

(b) m.s

(c) m/s

(d) s/m

Solution

Clue

We can obtain the dimensions of the quantity C_1 by equalizing the dimensions of the two sides of the equation and taking into consideration that the dimensional formula doesn't be added.

$$\therefore [x] = [C_1 t] = L$$

$$\therefore L = [C_1] T \quad \therefore [C_1] = \frac{L}{T} = LT^{-1}$$

$\therefore$ The measuring unit of C_1 is meter/second (m/s).

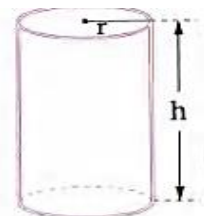
$\therefore$ The correct choice is (c).

If the pressure is the division of the force by area, find the dimensions of the pressure.
(Knowing that: Force (F) = Mass (m) $\times$ Acceleration (a), $[a] = LT^{-2}$)

-The Dimensional formula used to verify the validity of a physical relation.

For a cylinder of base radius r , height h and volume V , which of the following relations may be correct?

- (a) $V = \pi r h$ (b) $V = \pi r^2 h$ (c) $V = \pi \frac{r}{h}$ (d) $V = 2 \pi \frac{h^2}{r}$



Solution

* The relation is possible when the dimensions of the sides of the equation are equal.

$\therefore$ The dimensions of the L.H.S: $[V] = L^3$

$\therefore$ The dimensions of the R.H.S must equal L^3

The dimensions of the R.H.S

(a) $[\pi r h] = L L = L^2$ ☒	(b) $[\pi r^2 h] = L^2 L = L^3$ ☒	(c) $[\pi \frac{r}{h}] = \frac{L}{L} = L^0$ ☒	(d) $[2 \pi \frac{h^2}{r}] = \frac{L^2}{L} = L$ ☒
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A body moves under the effect of the acceleration due to gravity (g) where its speed gets changed from v_i to v_f during time t , so which of the following relations could be correct?

(Knowing that: $[g] = L T^{-2}$, $[v] = L T^{-1}$)

- (a) $v_f = v_i + gt$ (b) $v_f = v_i t + gt$ (c) $v_f = v_i + gt^2$ (d) $v_f = v_i t + gt^2$

Solution

* The relation is possible when the dimensions of all the sides of the equation are equal.

$\therefore$ The dimensions of the L.H.S: $[v_f] = L T^{-1}$

$\therefore$ The dimensions of the R.H.S must equal $L T^{-1}$

The dimensions of the R.H.S

(a) $[v_i] = L T^{-1}$ ☒	(b) $[v_i t] = L T^{-1} T = L$ ☒	(c) $[v_i] = L T^{-1}$ ☒	(d) $[v_i t] = L T^{-1} T = L$ ☒
$[gt] = L T^{-2} T = L T^{-1}$	$[gt] = L T^{-2} T = L T^{-1}$	$[gt^2] = L T^{-2} T^2 = L$	$[gt^2] = L T^{-2} T^2 = L$

Measurement Error

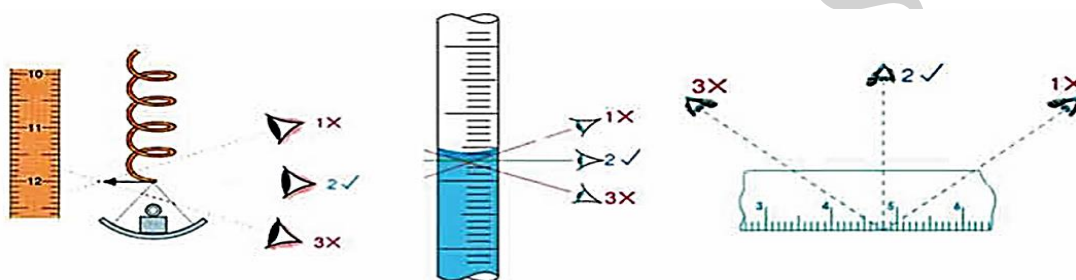
-Reasons (sources) of measurement error, such as:

1- Choosing an improper tool.

2- A defect in the measuring tool as the defects that may be in ammeter.



3- Wrong procedure due to the lack of experience of persons.



4- Environmental conditions, for example : temperature ,humidity, Air currents.



Types of measurement

Direct Measurement	Indirect Measurement
One measuring tool is used.	More than one measuring tool are used.
No mathematical relation is applied.	A mathematical relation is applied to find the quantity.
One measurement error may occur.	More than one measurement error may occur.
Like measure the density by using hydrometer.	Like measure the density by measure the mass and volume.



Dr. Ahmed Zewail

He won Nobel prize in 1999 for using a laser camera to study the mechanisms of chemical reactions between molecules that take place in a very short time estimated by femto -seconds (10^{-15} s)

Lord kelvin (William Thomson)

British scientist ,He is considered one of the most prominent scientists who developed the metric system ,He determined absolute zero on the Kelvin scale of temperatures with complete accuracy and found that it is equal to (-273 °C)



Unit (2) Linear motion
Ch.2 Motion in Straight line

Motion: Change in a position or location of an object as time passes relative to another static object.

-Simplest type of motion is motion in **straight line**, (Ex : motion of train)

Types of motion

Translational motion	Periodic motion
The motion which has starting point and end point.	The motion that repeats itself in equal interval of time.
Motion in straight line. Motion of projectiles (in curved path)	Motion in circle. Vibrational motion

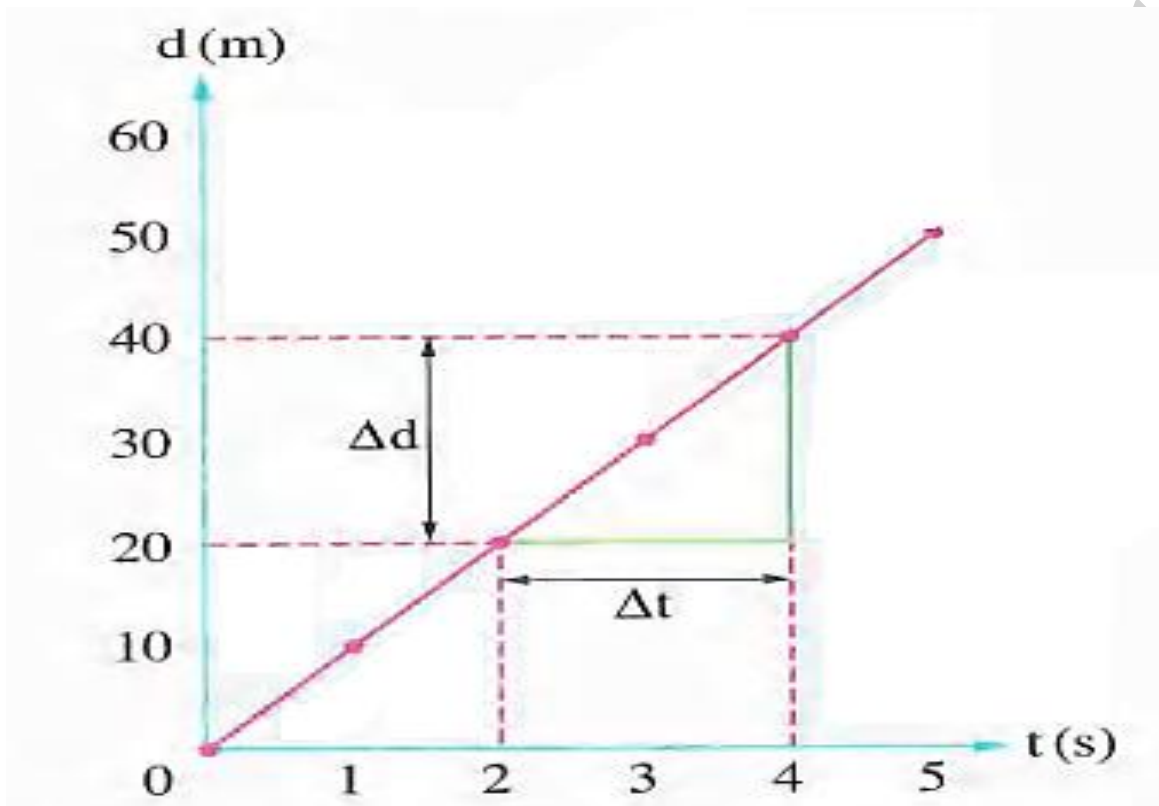
Velocity: The rate of change of displacement or displacement that covers in one second.

Measuring unit: m/sec or Km/h

To convert from m/sec to Km /h (divided by 5/18)

Graphical representation between time and displacement

-It represents by (displacement on y -axis and time on x- axis) the slope = velocity.

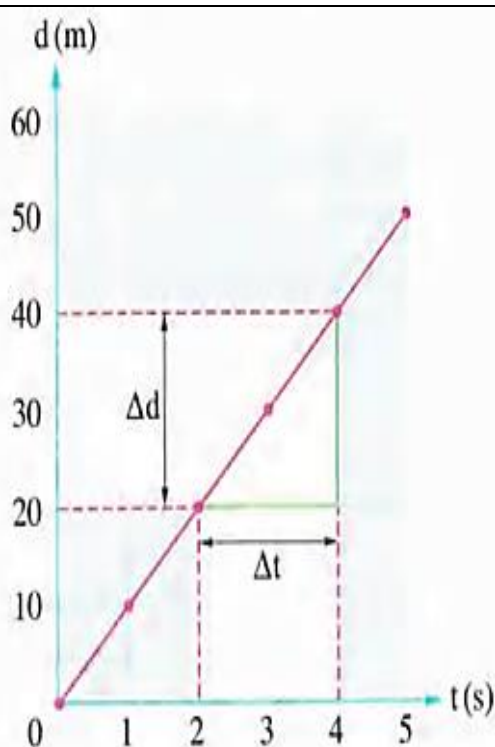


Velocity	Speed
The displacement of an object in one second.	The distance of an object in one second.
Vector quantity (defined by magnitude and direction)	Scalar quantity (defined by magnitude only)
Its sign may be positive or negative.	Always has positive sign.

Types of velocity

Uniform velocity

At which the objects move through equal displacements in equal interval of time.

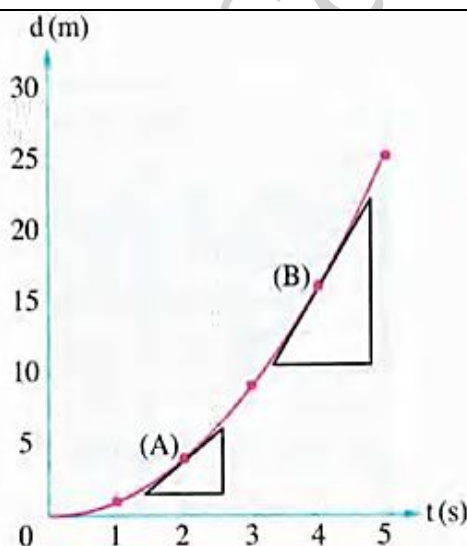


The slope of the straight line gives the magnitude of the uniform velocity at which the object moves:

$$\text{Slope} = v = \frac{\Delta d}{\Delta t} = \frac{40 - 20}{4 - 2} = 10 \text{ m/s}$$

Non uniform velocity

At which the objects move through unequal displacements in equal interval of time, or (equal displacement in unequal intervals of time.)



The slope of the tangent drawn to the curve at any point gives the magnitude of the instantaneous velocity of the object at this point:

- The velocity of the car at $t = 2 \text{ s}$

$$\text{Slope at (A)} = v_A = \frac{\Delta d_1}{\Delta t_1} = \frac{6.1 - 1.5}{2.6 - 1.45} = 4 \text{ m/s}$$

- The velocity of the car at $t = 4 \text{ s}$

$$\begin{aligned} \text{Slope at (B)} &= v_B = \frac{\Delta d_2}{\Delta t_2} \\ &= \frac{22 - 10.4}{4.8 - 3.35} = 8 \text{ m/s} \end{aligned}$$

Instantaneous velocity (v)

The velocity of the object at a given instant and it is defined by the time rate of change in displacement through a time interval that approaches zero.

Average velocity ($\bar{v}$)

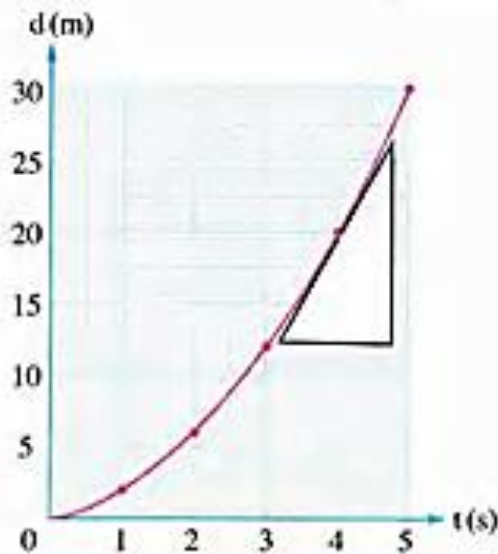
The total displacement of the object from the starting point to the end point of a definite time interval divided by that total time interval.

The mathematical relation

It is determined from the slope of the tangent of the (displacement-time) curve at a certain instant.

$$\bar{v} = \frac{d \text{ (Total displacement)}}{t \text{ (Total time)}}$$

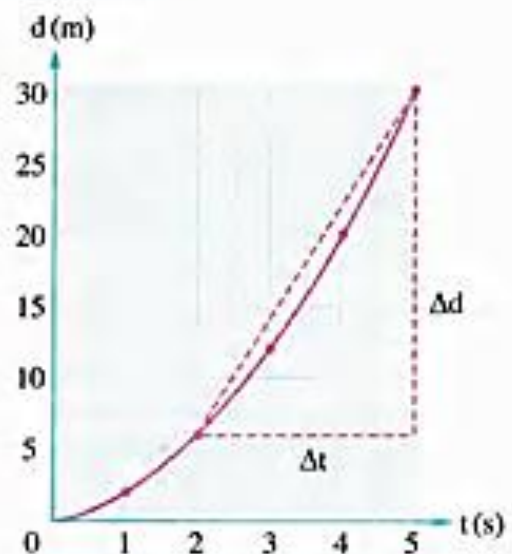
Graphical representation



The instantaneous velocity of an object at an instant is given by the slope of the tangent drawn to the curve at the point corresponding to that instant.

$$\begin{aligned} \text{Slope of tangent} = v &= \frac{26.5 - 12.5}{4.8 - 3.2} \\ &= 8.75 \text{ m/s} \end{aligned}$$

Which means that: The instantaneous velocity at $t = 4$ s is 8.75 m/s.



The average velocity of an object is given by the slope of the line joining the starting point and the end point of a certain interval of time.

$$\begin{aligned} \text{Slope of line} = \bar{v} &= \frac{\Delta d}{\Delta t} = \frac{30 - 6}{5 - 2} \\ &= 8 \text{ m/s} \end{aligned}$$

Which means that: The average velocity of the object from $t = 2$ s to $t = 5$ s is 8 m/s.

Acceleration

-If the velocity of an object changed from point to another either in magnitude or in direction, this change in velocity with time (rate of change of velocity) is known as acceleration and such motion is called **accelerated motion**.

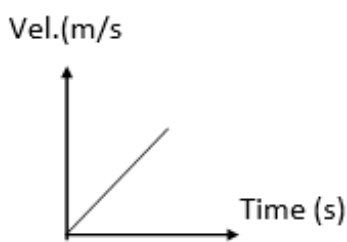
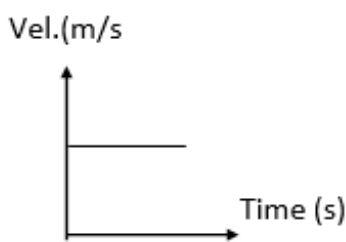
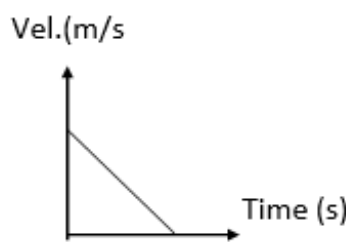
So, **acceleration** is the rate of change of velocity or change in velocity in one second.

Acceleration = Change in velocity/time of change
= final velocity – initial velocity / final time – initial time

- **Measuring unit** = m/s^2

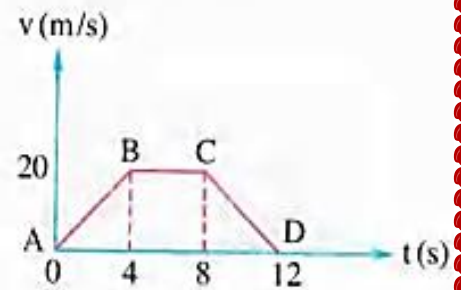
-**Dimensional formula** = LT^{-2}

Types of Acceleration

Positive acceleration.	Zero acceleration.	Negative acceleration.
When the velocity increase.	When the velocity is constant.	When the velocity decrease.
 Vel.(m/s) Time (s)	 Vel.(m/s) Time (s)	 Vel.(m/s) Time (s)

From the opposite graph:

- (a) Describe the type of motion by which the body moves within 12 s.
- (b) Calculate the acceleration in each interval.
- (c) Calculate the distance covered by the body during the interval BC.



Solution:

A -During the first 4 sec. the body is moving with positive uniform acceleration.

-During next 4 sec. the body is moving in uniform velocity (zero acceleration.)

-During the last 4 s the body is moving with a uniform acceleration (negative acceleration).

B-From A to B:

$$a = \text{change in velocity} / \text{change in time} = 20-0/4-0 = 5 \text{ m/s}^2$$

-From B To C:

$$a = \text{zero}$$

-From C to D:

$$a = 0-20/12-8 = -20/4 = -5 \text{ m/s}^2$$

c) The area under the curve during this time interval =

$$= 20 \times (8-4) = 80 \text{ m}$$

Ch.3 Motion and force

Force: External influence that affects the object to change its state of motion or direction.

-Appreciation to Galileo and Newton for their contribution in formulating a reliable theory of motion by the end of seventeenth century where they explored and explained the motion of bodies and its causes.



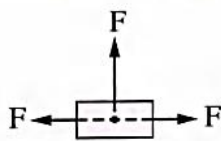
Newton's first law: A static object keeps its state of rest and a moving object keeps its state of motion at a uniform velocity in a straight line unless acted upon by a resultant force.

$$\Sigma F = 0$$

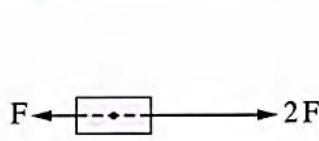
-So, if the force that affects an object = zero that means the velocity of the object doesn't change ($a = 0$)

Example

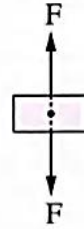
The following figures represent four static bodies, if they get affected by several forces as shown in the following figures, which one of these bodies remains static?



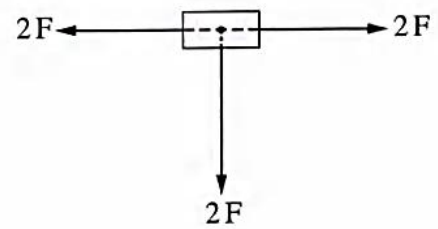
(a)



(b)



(c)



(d)

Inertia

It is the tendency of an object to keep either its state of rest or state of motion at its original velocity uniformly in a straight line.

Or: it is the property of objects to resist the change of its static or dynamic state.

When a bus moves forward suddenly from rest or when its velocity increases suddenly, the passengers tend to fall backward,



because the body (passengers) tends to keep its state of rest.

When the bus stops suddenly or when its velocity decreases suddenly, the passengers tend to fall forward,



because the body (passengers) tends to keep its state of motion.

Momentum: Mass x velocity , $P = m \times v$

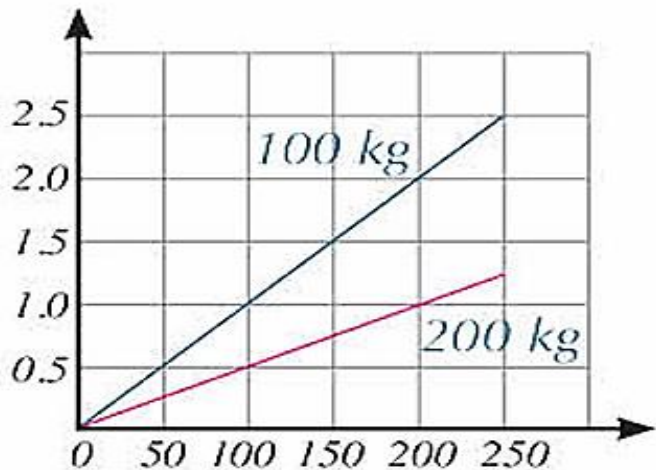
M.u = Kg.m/sec , **D.F = M L T⁻¹**

Newton's second Law: the total force that affect on an object equals the rate of change in momentum.

$$F = \frac{\Delta mv}{\Delta t} = \frac{mv_f - mv_i}{\Delta t} = m \frac{v_f - v_i}{\Delta t} = m \frac{\Delta v}{\Delta t}$$

$$F = m.a \quad , a = F/m$$

Acceleration



Force (N)

Newton: Measuring unit of force and it is defined as the force which is affected on an object whose mass of 1 kg gives it acceleration = 1 m/s²

$$1\text{N} = 1\text{Kg} \cdot \text{m} / \text{s}^2$$

Notes:

A car crashing into a wall is more devastating than a pile of hay.

* If a person falls from a high place into water, they will not be hurt, but if they fall to the ground, they may be hurt.

The severity of the injury increases with the height from which the person falls.

* If an egg falls on a pillow, it will not break, but if it falls to the ground, it will break.



-Air bags used to keep the driver when car stops suddenly.

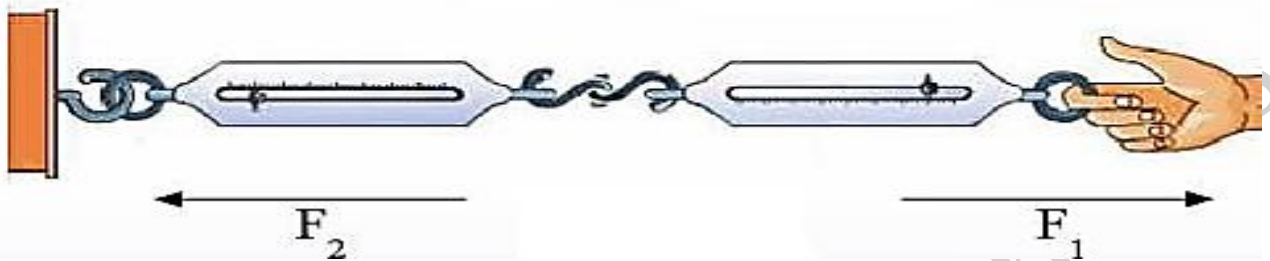
Newton's third Law

- When an object acts on another object by a force, the second object reacts with an equal force on the first object in a direction opposite to that of action.

Or: every action has reaction equal in magnitude and opposite in direction.



$$F_1 = -F_2$$



-The idea of working of rockets depends on Newton's third Law as the gases rush down and the rocket moves up.



- There is no single force in the universe, therefore, action and reaction arise together and disappear together.
- Action and reaction have one nature. If the action is a gravitational force, then the reaction is also a gravitational force.
- It cannot be said that the net result of action and reaction is zero, because they affect two different bodies